Effect of different GA$_3$ concentration and biofertilizer on growth and flowering parameters of anthurium (Anthurium andreanum Lindex Ex Andre) cv. tropical in soilless culture

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Abstract

An investigation was carried out during 2017-2018 to study the effect of GA$_3$ and biofertilizer on growth and flowering parameters of Anthurium (Anthurium andreanum Lindex Ex Andre) in soilless culture in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat, Assam. As a result, different growth and flowering parameters like the highest plant height (42.78 cm), highest number of leaves (9), highest leaf length (32.26 cm), highest leaf breadth (20.23 cm), highest leaf area (309.37 cm$^2$), highest plant spread (29.23 cm), highest number of sucker per plant (3.67), highest number of flower per plant (14.33), spathe length (18.98 cm), spathe breadth (13.43 cm) and flower stalk length (42.27 cm), highest self-life of spathe (52.20 days) and highest vase life of spathe (32.20 days) were found in treatment T$_3$ (Recommended dose of fertilizer i.e. RDF+ Azospirillum+ 100 ppm GA$_3$). Hence considering the positive effects on growth, flowering, yield and quality, T$_3$ can be considered for adopting at the field level to reap good economic yield with better quality and high net return.

Keywords: Anthurium andreanum, GA$_3$, biofertilizer, growth, flowering parameters

Introduction

Anthurium (Anthurium andreanum) is one of the most important ornamental evergreen flower crops which are grown in many parts of the world. Taxonomically Anthurium belongs to family Araceae. This evergreen plant is native to Columbia, Peru, Central and South America. Anthurium is also known as ‘tail flower’ (Tajuddin and Prakash, 1996) [28]. Anthurium are tropical plant of great beauty and grow either showy cut flowers or for other unusually attractive foliage. They are very popular among flower arrangers because of the bold effect and long-lasting quality of flower. It is well established that the growth and development of plants can be modified by exogenous application of growth substances through alteration in the levels of naturally occurring hormones. GA$_3$ is an important phytohormones and which is organic in nature, non-nutrients, produced by plants in low concentrations. GA$_3$ influences a range of developmental processes like cell division and expansion, growth of shoots, induce seeds germination that needs cold or light, stimulation of enzyme production such as - amylase in the germination of cereal seeds, induce flowering, sexual expression, fruit development, senescence and abscission, break of the yolk’s dormancy, maintenance of apical dominance and promotion of stem elongation (Laschi 1999) [13]. The continuous and unbalanced use of conventional fertilizers leads to decreased nutrient uptake efficiency of plants resulting in decreased crop yield. Eco-friendly, cost-effective and organic-based inputs such as botanical pesticides, biofertilizers, disease and pest-resistant varieties in cultivation of horticultural crops will be safeguarding the soil health, environment and quality production. The use of various bioinoculants like Azotobacter, Azospirillum and VAM along with PGPRs not only will supplement various nutrients in the soil or growing media but also improve the quality and quantity of crops. Although studies on effect of GA$_3$ and biofertilizer on different ornamental plants has been done earlier, but information available about their effect on Anthurium is limited. Hence, the present investigation was conducted to evaluate the effect of GA$_3$ and biofertilizer (Azospirillum) on growth, and flowering characteristics of Anthurium.

Materials and Methods

A field experiment under agro shade net house was conducted at Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat (26°47’ N and 94°12’E), during 2017-2018. The experiment was laid out in randomized block design with three replications. The treatments consisted of viz., T$_1$ – recommended dose of NPK fertilizers
period watering was

The suckers of grown Anthurium were planted in the 30 cm
raised beds framed with cemented bricks walls which hold the
growing media. The beds were constructed by giving a gentle
slope of 3 inch. The bed size was 1.2 m breadth and 12 m
length. In between two beds 80 cm gap was given. At bottom
black polythene is placed to prevent the contact of media with
soil. The beds were filled up with 10.2 cm (4 inches) layer of
brick pieces at the bottom, followed by 7.6 cm (3 inches) layer
of charcoal on its top followed by 5.1 cm (2 inches) layer of
brick pieces at the bottom, followed by 7.6 cm (3 inches) layer
of coco husk (3 cm X 3 cm pieces). A spacing of 30 cm in between
rows and 30 cm in between plants were maintained. For
planting of each sucker, a small pit was prepared and filled up
with coco peat and sand in 3:1 ratio. The 20 cm long uniform
suckers were root dip in biofertilizer (Azospirillum) slurry for
20 mints and after that they were planted in the small pits
prepared in the bed and the pits were filled up with coco peat
and sand in 3:1 ratio. Planting was done on 17th of January,
2017 with 15 plants per treatment at spacing of 30 cm among
plants and 30 cm from row to row. Different concentrations of
GA3 (100 ppm, 150 ppm, 200 ppm and 250 ppm) were applied
as foliar spray to the plants at 50 and 100 days after planting
for better growth and establishment. Care was taken so that
there was no drifting of spray solution from one treatment to
other. Fertilizer was applied in the form of complete fertilizer
i.e. 19 all @ 2 g/l for twice a week which is also the
recommended dose of fertilizer. The intercultural operation
like weeding and leaf pruning were done regularly. Manual
weeding was done regularly along with the roots and
removal of dead and decayed leaves of the plant at an interval
of 15-20 days to improve the vigor of the plants. Availability
of water is one of the most important factors for successful
Anthurium cultivation. During the dry period watering was
done twice a day and otherwise it was done once manually.

Results and Discussion

**Growth parameters**

**Plant height**
The highest plant height (Table 1 and Figure 1) of 42.78 cm
was recorded for the treatment T3 (RDF + Azospirillum + 100 ppm GA3) and second highest height of 40.66 cm was recorded for the treatment T7 (19 all+100 ppm GA3). This might be due to the fact that gibberellin stimulates the expression of enzymes involved in cell wall
loosening and genes controlling cell division and also
stimulates microtubule rearrangements associated with cell
expansion (Amber, 2012) [1]. Moreover, the root dip treatment
with Azospirillum provided a more balanced nutrition for plants
as well as optimum absorption of more nutrition by roots
accelerated the physiological process and improved the
general growth phenomenon. The increase in plant height was
due to the presence of a readily available form of nitrogen
(Sankari et al., 2015) [24].

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Plant height (cm)</th>
<th>No. of leaves</th>
<th>Leaf length(cm)</th>
<th>Leaf breadth (cm)</th>
<th>Leaf area (cm²)</th>
<th>Plant spread(cm)</th>
<th>No. of sucker per plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 - Recommended dose of NPK fertilizers @ 19:19:19 (RDF)</td>
<td>33.85</td>
<td>5.67</td>
<td>24.05</td>
<td>17.26</td>
<td>193.24</td>
<td>22.53</td>
<td>1.00</td>
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<tr>
<td>T2 - RDF + Azospirillum</td>
<td>35.76</td>
<td>7.00</td>
<td>25.13</td>
<td>17.73</td>
<td>213.86</td>
<td>23.86</td>
<td>1.00</td>
</tr>
<tr>
<td>T3 - RDF + Azospirillum + 100 ppm GA3</td>
<td>42.78</td>
<td>9.00</td>
<td>32.26</td>
<td>20.23</td>
<td>309.37</td>
<td>29.23</td>
<td>3.67</td>
</tr>
<tr>
<td>T4 - RDF + Azospirillum + 150 ppm GA3</td>
<td>39.11</td>
<td>7.00</td>
<td>27.32</td>
<td>18.83</td>
<td>291.26</td>
<td>24.90</td>
<td>1.66</td>
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<tr>
<td>T5 - RDF + Azospirillum + 200 ppm GA3</td>
<td>38.23</td>
<td>6.67</td>
<td>25.87</td>
<td>18.26</td>
<td>280.29</td>
<td>24.80</td>
<td>1.33</td>
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<td>35.06</td>
<td>5.67</td>
<td>23.16</td>
<td>17.30</td>
<td>229.50</td>
<td>23.23</td>
<td>0.67</td>
</tr>
<tr>
<td>T7 - RDF + 100 ppm GA3</td>
<td>40.66</td>
<td>8.00</td>
<td>29.89</td>
<td>19.57</td>
<td>296.97</td>
<td>27.03</td>
<td>2.00</td>
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<tr>
<td>T8 - RDF + 150 ppm GA3</td>
<td>37.15</td>
<td>6.33</td>
<td>25.45</td>
<td>18.56</td>
<td>245.40</td>
<td>24.70</td>
<td>1.67</td>
</tr>
<tr>
<td>T9 - RDF + 200 ppm GA3</td>
<td>36.31</td>
<td>6.33</td>
<td>25.05</td>
<td>17.86</td>
<td>237.06</td>
<td>23.76</td>
<td>1.33</td>
</tr>
<tr>
<td>T10 - RDF + 250 ppm GA3</td>
<td>34.95</td>
<td>5.67</td>
<td>23.47</td>
<td>16.90</td>
<td>221.03</td>
<td>23.13</td>
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<td>S.Ed. (±)</td>
<td>1.15</td>
<td>0.52</td>
<td>0.99</td>
<td>0.27</td>
<td>1.69</td>
<td>1.62</td>
<td>0.42</td>
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<td>CD0.05</td>
<td>2.54</td>
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<td>2.10</td>
<td>0.57</td>
<td>3.55</td>
<td>3.41</td>
<td>0.85</td>
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</tbody>
</table>

Table 1: Effect of GA3 and biofertilizers on growth parameters of Anthurium after 360 days after planting (DAP)

![Fig 1: Plant heights in different growth stage](http://www.phytojournal.com)
Number of leaves per plant

The leaves serve as the active site for food synthesis in plant. The highest number of leaves per plant (Table 2 and Figure 2) was recorded in the treatment $T_3$ (19all+Azospirillum+100ppm GA$_3$) i.e. 9.00 and $T_7$ (19 all+100ppm GA$_3$) i.e. 8.00. Gibberellic acid increases the alpha amylase activity, auxin stimulating effect and cell wall loosening, increased cell elongation along with the cell enlargement. All these caused effect on increased number of leaves, thereby causing increased photosynthetic area. Thus, this caused increase in carbohydrate food material (Chaudhari 2003) [6]. Bio-fertilizers increase the absorption of the macro and micro nutrients of plant. Production of more number of leaves might also be due to the increased availability of N in growing media, which is an important component of chlorophyll and protein thus causing more growth (Kumar and Singh, 2007) [11].

Table 2: Effect of GA$_3$ and biofertilizers on yield parameters of Anthurium after 360 days after planting (DAP)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>No. of flower per plant</th>
<th>Spathe length (cm)</th>
<th>Spathe breadth (cm)</th>
<th>Stalk length (cm)</th>
<th>Self-life (days)</th>
<th>Vase life (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T$_1$ – Recommended dose of NPK</td>
<td>5.63</td>
<td>14.17</td>
<td>8.58</td>
<td>28.17</td>
<td>38.13</td>
<td>18.40</td>
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<td>fertilizers 19:19:19 (RDF)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T$_2$ – RDF + Azospirillum</td>
<td>6.26</td>
<td>14.54</td>
<td>9.00</td>
<td>29.40</td>
<td>39.23</td>
<td>18.80</td>
</tr>
<tr>
<td>T$_3$ – RDF + Azospirillum + 100 ppm GA$_3$</td>
<td>14.33</td>
<td>18.98</td>
<td>13.43</td>
<td>42.47</td>
<td>52.20</td>
<td>32.60</td>
</tr>
<tr>
<td>T$_4$ – RDF + Azospirillum + 150 ppm GA$_3$</td>
<td>10.37</td>
<td>16.00</td>
<td>11.03</td>
<td>36.83</td>
<td>48.33</td>
<td>23.43</td>
</tr>
<tr>
<td>T$_5$ – RDF + Azospirillum + 200 ppm GA$_3$</td>
<td>9.34</td>
<td>15.54</td>
<td>10.86</td>
<td>33.90</td>
<td>46.73</td>
<td>21.80</td>
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<tr>
<td>T$_6$ – RDF + Azospirillum + 250 ppm GA$_3$</td>
<td>7.30</td>
<td>13.83</td>
<td>8.91</td>
<td>29.30</td>
<td>40.37</td>
<td>19.43</td>
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<tr>
<td>T$_7$ – RDF + 100 ppm GA$_3$</td>
<td>12.01</td>
<td>16.56</td>
<td>11.75</td>
<td>39.93</td>
<td>49.16</td>
<td>25.26</td>
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<tr>
<td>T$_8$ – RDF + 150 ppm GA$_3$</td>
<td>8.65</td>
<td>15.11</td>
<td>10.34</td>
<td>32.76</td>
<td>45.50</td>
<td>21.40</td>
</tr>
<tr>
<td>T$_9$ – RDF + 200 ppm GA$_3$</td>
<td>8.07</td>
<td>14.98</td>
<td>9.87</td>
<td>31.73</td>
<td>43.27</td>
<td>20.63</td>
</tr>
<tr>
<td>T$_{10}$ – RDF + 250 ppm GA$_3$</td>
<td>7.33</td>
<td>13.43</td>
<td>8.32</td>
<td>29.23</td>
<td>40.30</td>
<td>19.33</td>
</tr>
<tr>
<td>S.Ed. (±)</td>
<td>0.98</td>
<td>1.12</td>
<td>0.93</td>
<td>1.24</td>
<td>1.15</td>
<td>0.15</td>
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<tr>
<td>CD$_{05}$</td>
<td>2.06</td>
<td>2.35</td>
<td>1.95</td>
<td>2.64</td>
<td>2.45</td>
<td>0.31</td>
</tr>
</tbody>
</table>

Fig 2: Number of leaves at different growth stages

Leaf length and breadth (cm)

Significant increase in leaf length and breadth (32.26 cm and 20.23 cm respectively) was found for the treatment $T_3$ (RDF+Azospirillum+100ppm GA$_3$) showed in Table 1. Foliar application of GA$_3$ might have influenced cell division and cell elongation resulting in enhanced vegetative growth of plant which also influences the better leaf growth. The other notable cause may be due to increased absorption of nutrients which resulted in increase in the synthesis of carbohydrates, chlorophyll content and increase the activity of hormones produced by Azospirillum. It also helped better proliferation of root growth and uptake of other nutrients to a great extent (Patel et al., 2016) [19].

Leaf area (cm$^2$)

The leaf area is an important attribute as it has direct relevance with interception of light and photosynthesis and ultimately with overall growth and development. The maximum leaf area (309.37 cm$^2$ and 296.97 cm$^2$) were recorded for the treatment $T_3$ (RDF+Azospirillum+100ppm GA$_3$) followed by $T_7$ (RDF+100ppm GA$_3$) and this is showed in Table 1. This might be attributed to the fact that there was a concurrent increase in leaf numbers. More leaves with more photosynthetic area were capable of maintaining a high correlation with source-sink relationship obtained through foliar spray of GA$_3$ (Marchner, 1986) [15]. The use of biofertilizer has long been recognized as an effective means
of improving the structure and fertility of the soil and growing media increasing the microbial diversity, activity and population, improving the moisture-holding capacity of growing media and crop yield (Frederickson et al. 1997) [8].

Plant spread (cm)
The plant spread (Table 1) was found significantly maximum in the treatment T₃ (RDF+Azospirillum+100ppm GA₃). The increase in plant spread these treatments could be attributed to the physiological action of GA₃. Highest plant spread may be due to highest plant height, maximum leaf area and maximum number of leaves. According to Verma (1991) [29] it was due to the formation of new cells in meristematic region and an increase in size and mass of cells produced. Bio-fertilizers increase the absorption of the macro and micro nutrients of plant which influences the overall growth of the plant. Significant increase in spread due to application of Azospirillum, and inorganic fertilizers has been reported earlier in Marigold (Sharma et al., 2015) [28].

Number of suckers per plant
In the present study the number of suckers per plant was influenced significantly by plant growth regulators. T₃ (RDF+Azospirillum+100ppm GA₃) recorded the maximum number of suckers per plant followed by T₇ (RDF+100ppm GA₃) respectively which is showed in Table 1 and Figure 3. This is in agreement with the findings of Reddy et al. (1997) [22] in China aster. The higher number of suckers by using GA₃ might be due to increase in the number and size of leaves as a result of higher translocation of the photosynthates and eventually that would have been used for the production of propagules (suckers) (Sharifuzzaman et al., 2011) [25] and Maitra and Roychoudhury (2014) [14] in Anthurium. More number of sucker’s production may be due to the bioactive substances produced by Azospirillum and the better network of mycorrhizal hyphae around root zone This result are in agreement with Chandrappa (2002) [5] in Anthurium.

Flowering parameters
Number of flowers per plant
The number of flowers per plant is the major yield contributing factor in anthurium. The number of flowers per plant was significantly influenced by the different treatments. The treatment T₃ (RDF+Azospirillum + 100ppm GA₃) resulted in highest number of flowers i.e. 14.33 (Table 1 and Figure 3). The probable reason for increase in the number of flowers could be due to the effect of gibberellic acid on transformation of metabolites from vegetative phase to reproductive phase by increasing number of flower buds. These results are in line with findings of Henny and Hamilton (1992) [10], Purwoko et al. (1997) [21] Anjali et al. (2014) [2] in Anthurium. The highest number of flowers was found in the treatments which were treated with biofertilizer. This may be also due to Azospirillum which might have stimulated the rate of multiplication of lateral roots and root surface area so as to absorb more nutrients from media for flower production. Similar results were reported by Jawaharlal and Padmadevi (2004) [12], in Anthurium.

Spathe length (cm) and Spathe breadth (cm)
Marked differences were noticed among the treatments on spathe length and spathe breadth. The highest spathe length and breadth were noticed for the treatment T₃ (RDF+Azospirillum+100ppm GA₃) and the second highest spathe length and breadth were noticed for T₇ (RDF+100ppm GA₃) which is showed in Table 2 and Figure 4. The role of GA₃ in improving the spathe size may be ascribed to the translocation of metabolites at the site of spathe development. Gibberellic acid has been reported to induce an entire developmental program by activation of regulatory genes in the later stages of corolla development as observed by Preethi (1990) [20] in rose. The increased spathe width might also be due to the role of biofertilizers in enhancing nutrient uptake and helped in production of auxin like substances which may be responsible for better translocation of photosynthates from site of synthesis to apical region and there by increased the spathe width. The present findings are in line with the reports of Pandey et at., (2017) [17] in Dahlia, Pansuriya et al., (2018) [18] in Gladiolus.
Flower stalk length (cm)
Flower quality parameters like flower stalk length was greatly influenced by the application of GA3 and biofertilizer. The highest stalk length was recorded for 100 ppm GA3. The gibberellic acid application accelerates cell division and longitudinal growths of the cell and plants as a result stem length and plant height increased simultaneously. This result is in line with findings of Sainath (2009) in chrysanthemum and Muthu Kumar et al., (2012) in rose. Due to application of biofertilizer better nutrient uptake, photosynthesis, source-sink relationship along with excellent physiological and biochemical activities prevail in the root zone. Similar results were also observed by Gupta et al., (2008) in gladiolus.

Self-life and vase life of flower (days)
Like all other morphological characters in terms of superiority caused by T3 (RDF + Azospirillum + 100ppm GA3), the highest self-life of spathé (52.20 days) and vase life of spike (32.60 days) was recorded for the treatment T3 (RDF + Azospirillum + 100ppm GA3) which is showed in Table 2. These results are in corroboration with the findings of Barreto et al. (2002) in gerbera. It might also be due to overall food and nutrient status of flowers under the treatments. Srivastava et al. (2007) reported the effect of Azospirillum and organic manures on the post-harvest quality of tuberose cv. Double and showed significant increase in vase life over the untreated control. This might be due to the availability of N to the plant which improves the quality of flower due to better phosphorelation in plants.

The results of the present investigation revealed that treatment T3 (RDF+Azospirillum+100ppm GA3) and T7 (RDF+100ppm GA3) were found to be the most efficient treatments in terms of both growth and flowering. Hence, these two treatments may be adopted by the growers for commercial cultivation of Anthurium to feed national and international market.

References
9.  Gupta P, Neeraj R, Dhaka VK, Dheeraj R. Effect of different levels of vermicompost, NPK and FYM on